

# Benefit/Cost Analysis Worksheet (Intersection) Virginia Highway Safety Improvement Projects (FY2007-08)

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General Information	Route	Jurisdiction	Location Description				Traffic Control	Major Road	Cross Road	Study Period Begins	Study Period Ends		
	US1	Richmond District	At the Intersection of E.Broad St and 14th St.				Signal		14 St.	06/22/02	06/24/05		
	Problem and Proposed Work		The intersection of Broad Street and 14 St has 4 right angle crashes, pavement widen, signal optimization is suggested.										
Crash Data	Collision Type		Rear End	Sideswipe Same Direction	Left Turn	Right angle	Ran off Road	Head On/ Sideswipe - Opposite	Pedestrian	Other(1)	Other(2)	Total Related Crashes	Total Crashes
	Personal Injury/Fatal	F										0	
		A										0	
		B										0	
		C										0	
		PD										0	
		Total	0	0	0	0	0	0	0	0	0	0	0
List FR300 Doc. # of All Related Crashes													
Traffic Data	Period	Average AADT	NB	SB	EB	WB	Other	# of Approaches	Crash Rate	Critical Rate	Top 100?	Traffic Growth Rate	
	99-02	2000							0.00	0.023			
Improvement Action	Number of Improvements		Discount Rate		5.0%		Project Cost						
	Number	Improvement Description	Servie Life	PRF	PRI	PRPD	PE cost	R/W & Utility	Construction	Annual Initial Cost	Annual Maintenance		
	1												
	2												
	3												
	4												
	Total		0				Total Initial Cost	\$ -	Total	\$ -	0		
B/C Calculation							Project Benefit						
	Benefit	Total Annulized Benefit		Traffic Growth Factor(TGF)		Total Benefit	Type of Crash	Related Crash #	Annual Reduction	Cost per Crash	Annual Benefit		
		\$ -					F	0		\$ 1,000,000			
	Cost						A	0		\$ 500,000			
		Total Annulized Initial Cost		Total Annual Maintenance Cost		Total Cost	B	0		\$ 16,500			
		\$ -		\$ -		\$ -	C	0		\$ 9,400			
							PD	0		\$ 6,500			
B/C=						Total				\$ -			

1. The yellow area are required inputs and white areas are optional. The grey areas are automatically generated by embedded formulas.  
2. In traffic data section, critical rate refers to the critical crash rate of intersections which have similar geometry and location.

## Instructions for Benefit/Cost Analysis Worksheet for Intersection Safety Improvement Projects

A Microsoft Excel (XLS) worksheet has been developed to assess the eligibility of a proposed improvement or group of coordinated improvements at an intersection. Improvements that provide expected crash reductions resulting in a benefit to cost ratio (B/C) greater than one (1.0) are eligible for HSIP funding. The B/C plus the number of severe crashes reduced, improvement cost will be used to prioritize the eligible improvements.

The XLS consists of five sections: General Information, Crash Data, Traffic Data, Improvement Action, and B/C Calculation. The yellow areas of the sheet are **required** inputs and white areas are optional. The grey areas are automatically generated by embedded formulas. All areas other than input areas are protected to ensure the accuracy and consistency of the worksheet. The following sections explain each field (cell) of the XLS sheet. The fields with an asterisk (\*) are required.

### General Information Section

**Route\*:** Input route name of major direction, such as US1, SR6, Broad Street. If known, the 14 character VDOT name (Prefix, Route #, Suffix) should be provided.

**Jurisdiction\*:** Input jurisdiction of the location, such as City of Richmond, Fairfax County

**Location Description\*:** Give a brief description of the improvement location; for example, on the south approach of the 1<sup>st</sup> and A Street intersection

**Traffic Control\*:** Input traffic control information, such as signal, four way stop, etc.

**Major Road\*:** Input name of the major road of the intersection

**Cross Road\*:** Input name of the cross (minor) road of the intersection

**Study Period Begins\*:** Input the begin date of three (3) year traffic crash data collection period in the format of mm/dd/yy

**Study Period Ends\*:** Input the finish date of three year traffic crash data collection period in the format of mm/dd/yy.

**Problem and Proposed work\*:** A brief explanation of why this location is chosen for safety improvement by identifying current or potential safety problems or concerns and proposed cost-effective safety countermeasures

### Crash Data Section

Additional crash report information is now required compared to previous applications. Improvement eligibility will be based on the cost-effectiveness of reducing severe crashes at the location. **Crash Summary sheet must be used to fill this section.**

**Crash Severity\*:** The most severe vehicle occupant injury for each crash must be determined to categorize the crash using the KABCO scale. Since January 2004, the Virginia Police Crash Report (FR-300) indicates the severity of occupant injury in Field number 19; prior to 2004, Field # 15 of the FR-300 was used. The FR-300 Field 19 corresponding codes with the KABCO scale are as follows:

K= code of 1, dead before report (on scene), and code of 5, died later

A= code of 2, major visible injury

B= code of 3, minor visible injury  
C= code of 4, complaint of but not visible injury  
O= no codes, property damage only crash

**Each crash must be classified by the most severe outcome for all the occupants for each crash targeted for reduction (related crash) by the improvement.**

**Crash Type\*:** Several major types of crashes are listed; user can input additional collision types such as “Night”, “Wet Pavement” in “Others (1)” and “Others (2)”.

**Total Related Crashes\*:** Input the total target crashes related to the proposed countermeasures in this location. Please refer “improvement type” for target crash type for the countermeasure.

**Total Crashes:** Input the total crashes that occurred at this location, which should be more than or at least equal to Total Related Crashes. For example, include crashes on all approaches or other types not related to the improvement. This information will be used to evaluate the overall program effectiveness.

**List FR300 Doc. # of All Related Crashes:** Input the FR300 Document number for all related crashes.

## **Traffic Data Section**

**Period:** Input the year of traffic data, such as 2003-05

**Inter. AADT:** Input Annual Average Daily Traffic (AADT) entering the intersection on all approaches. That is, one-half of the total AADT on the approaching roadway links.

**Crash Rate:** Automatically calculated as 
$$\frac{\text{TotalCrashes} * 1,000,000}{\text{AADT} * 365 * 3}$$

**Critical Rate:** If known, input the critical rate for a similar location in that VDOT District

**Top 5%?:** Input “Yes” or “No” depending on if it is one of the top 5 percent high crash locations identified each year. This field is presently not required as procedures will be developed to identify those locations.

**Traffic Growth Rate\*:** Input the projected annual traffic growth rate for the area over the expected life of the improvement (normally based on last 10 to 20 years). This number will vary by jurisdictions and should be available from VDOT Transportation Planning offices.

## **Improvement Action Section**

**Number of Improvements\*:** Enter total number of improvement actions (Contact HSIP staff if over 4 improvement actions are proposed)

**Discount Rate\*:** Equals to 5.0% (given by Central Office based on the latest Federal Reserve Fund rate as of 5/10/06.)

**Improvement Description\*:** Select improvement action from “Improvement Table”

**Service Life\*:** Input the corresponding service life from “Improvement Table”

**PRF\*:** Percentage Reduction of Fatal Crashes; Input the corresponding number from “Improvement Table”

**PRI\*:** Percentage Reduction of Injury Crashes; Input the corresponding number from “Improvement Table” Sheet.

**PRPD\*:** Percentage Reduction of Property Damage Only Crashes, Input from “Improvement Table” Sheet

**Total- Service life:** equals to maximum number of service life of all improvement actions.

**Total-PRF:** Equals  $1 - \prod_{k=1}^m (1 - PRF_k)$ , where m=number of improvement actions.

**Total-PRI:** Equals  $1 - \prod_{k=1}^m (1 - PRI_k)$ , where m=number of improvement actions.

**Total-PRPD:** Equals  $1 - \prod_{k=1}^m (1 - PRPD_k)$ , where m=number of improvement actions.

### ***Project Cost***

Costs are required to be generated by PCES or most recent line item costs used by locality.

**PE Cost\*:** Current value of Preliminary Engineering Cost for each improvement action

**R/W&Utility\*:** Current value of Right way and Utilities Cost for each improvement action

**Construction\*:** Current value of Construction Cost for each improvement action

**Annualized Initial Cost:** Annualized cost for each improve action over its service life

**Annual Maintenance:** Annual maintenance cost for each improvement action using best available information.

### **B/C Calculation Section**

**Total Annualized Benefit:** Equals the sum of Annul Benefit from the reduction of each related injury type crash

**Traffic Growth Factor:** Equals  $(1 + g) * \frac{(1 + g)^n - 1}{g \times n}$ , where  $g$  =annual traffic growth rate  
and  $n$  =improvement action  
service life

**Total Benefit:** Equals Total Annualized Benefit \* Traffic Growth Factor

**Total Annualized Initial Cost:** Sum of the annualized initial cost for all improvement actions.

**Total Annual Maintenance Cost:** Sum of the annual maintenance cost for all improvement actions

**Total Cost:** equals to Total Annualized Initial Cost +Total Annual Maintenance Cost

**B/C:** equals to Total Benefit/Total Cost for the defined life of the improvement.

### ***Project Benefit***

**Related Crash #:** Number of related crashes by severity type in the study period (3 years)

**Annual Reduction:** Annual reduction number of related crashes by severity type

**Cost per Crash:**

Fatal: \$3,760,000<sup>1</sup>

Injury type A: \$188,000<sup>1</sup>

Injury type B: \$48,200<sup>1</sup>

Injury type C: \$22,900<sup>1</sup>

Property Damage Only: \$6,500<sup>2</sup>

Source:

1. National Safety Council (NSC), 2005 Injury Facts; Estimating the Costs of Unintentional Injuries, 2005
2. Hanley, Paul, The University of Iowa, Using Crash Costs in Safety Analysis, 2004, original source from:

## Instructions for Benefit/Cost Analysis Worksheet for Section Safety Improvement Projects

A Microsoft Excel (XLS) worksheet has been developed to assess the eligibility of a proposed improvement or group of coordinated improvements at a highway section. Improvements that provide expected crash reductions resulting in a benefit to cost ratio (B/C) greater than one (1.0) are eligible for HSIP funding. The B/C plus the number of severe crashes reduced, improvement cost will be used to prioritize the eligible improvements.

This worksheet consists of five sections: General Information, Crash Data, Traffic Data, Improvement Action, B/C Calculation.

The yellow areas are **required** inputs and white areas are optional. The grey areas are automatically generated by embedded formulas. All areas other than input areas are protected to ensure the accuracy and consistency of the worksheet. The following explain each field (cell) of the XLS sheet. The fields with an asterisk (\*) are required.

### General Information Section

**Route\*:** Input route name of major direction, such as US1, SR6, Broad Steet. If known, the 14 character VDOT name (Prefix, Route #, Suffix) should be provided.

**Jurisdiction\*:** Input jurisdiction of the location, such as City of Richmond, Fairfax County.

**Location Description\*:** Give a brief description of the improvement location, for example, on the south approach of 1<sup>st</sup> and A Street intersection

**Road Classification\*:** Input road classification such as interstate, primary or secondary

**From\*:** Input the reference point of the beginning of the section

**To\*:** Input the reference point of the end of the section

**Study Period Begins\*:** Input the begin date of three (3) year traffic crash data collection period

**Study Period Ends\*:** Input the finish date of three (3) year traffic crash data collection period

**Problem and Proposed work\*:** A brief explanation of why this location is chosen for safety improvement by identifying current or potential safety problems or concerns and proposing cost-effective safety countermeasures

### Crash Data Section

Additional crash report information is now required compared to previous applications. Improvement eligibility will be based on the cost-effectiveness of reducing severe crashes at the location. **Crash Summary sheet must be used to fill this section.**

**Crash Severity\*:** The most severe vehicle occupant injury for each crash must be determined to categorize the crash using the KABCO scale. Since January 2004, the Virginia Police Crash Report (FR-300) indicates the severity of occupant injury in Field number 19; prior to 2004, Field # 15 of the FR-300 was used. The FR-300 Field 19 corresponding codes with the KABCO scale are as follows:

K= code of 1, dead before report (on scene), and code of 5, died later  
 A= code of 2, major visible injury  
 B= code of 3, minor visible injury  
 C= code of 4, complaint of but not visible injury  
 O= no codes, property damage only crash

**Each crash must be classified by the most severe outcome for all the occupants for each crash targeted for reduction (related crash) by the improvement.**

**Crash Type\*:** Several major types of crashes are listed; user can input additional crash types such as “Night crashes” or “Wet Pavement” in “Others (1)” and “Others (2)”.

**Total Related Crashes\*:** Input the total targeted crashes related to the proposed countermeasures in this location. Please refer “improvement type” for target crash type for the countermeasure.

**Total Crashes:** Input the total crashes that occurred at this location, which should be more than or at least equal to Total Related Crashes. For example, include crashes on all approaches or other types not related to this improvement. This information will be used to evaluate the overall program effectiveness.

**List FR300 Doc. # of All Related Crashes:** Input the FR300 Document number for all related crashes.

## Traffic Data Section

**Period\*:** Input the year of traffic data, such as 99-02

**Section Length\*:** Input the section length in mile

**Average AADT\*:** Input Annual Average Daily Traffic on each road section

**Number of Lanes\*:** Input number of lanes for each section

**Crash Rate:** Automatically calculated as  $\frac{TotalCrashes * 100,000,000}{\sum_{i=1}^n Sectionlength * AADT * 365 * 3}$ , where n is number

of sections

**Critical Rate:** Input the critical rate for a similar location in that district

**Top 5%?:** Input “Yes” or “No” depending on if it is one of the top 5 percent high crash hazard locations identified each year. This field is presently not required as procedures will be developed to identify those locations.

**Traffic Annual Growth Rate\*:** Input the projected annual traffic growth rate for the area over the expected life of the improvement (normally based on last 10 to 20 years). This number will vary by jurisdictions and should be available from VDOT Transportation Planning offices.

## Improvement Action Section

**Number of Improvements\*:** Enter total number of improvement actions (Contact HSIP staff if over 4 improvement actions are proposed)

**Discount Rate:** Equals to 5.0% based on Federal Reserve fund rate as of 5/10/06

**Improvement Description:** Select improvement action from “Improvement Table”.

**Service Life\*:** Input the corresponding service life from “Improvement Table”

**PRF\*:** Percentage Reduction of Fatal Crashes; Input the corresponding number from “Improvement Table”.

**PRI\*:** Percentage Reduction of Injury Crashes; Input the corresponding number from “Improvement Table”.

**PRPD\*:** Percentage Reduction of Property Damage Only Crashes, Input from “Improvement Table”.

**Total- Service life:** Equals to maximum number of service life of all improvement actions.

**Total-PRF:** Equals to  $1 - \prod_{k=1}^m (1 - PRF_k)$ , where m=number of improvement actions.

**Total-PRI:** Equals to  $1 - \prod_{k=1}^m (1 - PRI_k)$ , where m=number of improvement actions.

**Total-PRPD:** Equals to  $1 - \prod_{k=1}^m (1 - PRPD_k)$ , where m=number of improvement actions.

### ***Project Cost***

Costs are required to be generated by PCES or most recent line item costs used by locality.

**PE Cost\*:** Current value of Preliminary Engineering Cost for each improvement action

**R/W & Utility\*:** Current value of Right way and Utilities Cost for each improvement action

**Construction\*:** Current value of Construction Cost for each improvement action

**Annualized Initial Cost\*:** Annualized cost for each improve action over its service life

**Annual Maintenance:** Annual maintenance cost for each improvement action using best available information

### **B/C Calculation Section**

**Total Annualized Benefit:** Equals to the sum of Annul Benefit from the reduction of each related injury type crashes

**Traffic Growth Factor:** Equals to  $\frac{(1+g)((1+g)^n - 1)}{g \times n}$ , where  $g$  =annual traffic growth rate and  $n$  =improvement action service life

**Total Benefit:** Equals to Total Annualized Benefit \* Traffic Growth Factor

**Total Annualized Initial Cost:** Sum of the annualized initial cost for all improvement actions.

**Total Annual Maintenance Cost:** Sum of the annual maintenance cost for all improvement actions

**Total Cost:** Equals to Total Annualized Initial Cost plus Total Annual Maintenance Cost

**B/C:** Equals to Total Benefit/Total Cost for the Defined life of the improvement.

### ***Project Benefit***

**Related Crash #:** Number of related crashes by severity type in the study period (3 years)

**Annual Reduction:** Annual reduction number of related crashes by severity type

**Cost per Crash:**

Fatal: \$3,760,000<sup>1</sup>

Injury type A: \$188,000<sup>1</sup>

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Property Damage Only: \$6,500<sup>2</sup>

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